SIEMENS

BEAMVIEW
DICOM Conformance Statement

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1 Introduction

This document serves as a DICOM Conformance Statement for SIEMENS BEAMVIEW portal imaging product. When used in conjunction with *mc² Scientific Systems*' DICOM Gateway product, BEAMVIEW version 2.1, conforms to the requirements of both a DICOM Service Class Provider (SCP) and a DICOM Service Class User (SCU). The DICOM Gateway product provides the TCP/IP communications, association negotiation, and message receiving and sending capabilities of a standard SCP/SCU. The BEAMVIEW application handles the data extraction and integration functions of an SCP as well as the data encoding functions of an SCU. The intended audiences for this document are image equipment manufacturers and end users who wish to import or export image objects into and out of SIEMENS BEAMVIEW product.

This document has been written in accordance with part PS 3.2 of the DICOM 3.0 standard.

References

The following documents are referenced within this standard:

Digital Imaging and Communications in Medicine (NEMA: PS3.1 - PS3.13 1996)

DICOM Supplement 11: Radiotherapy Objects (NEMA: 14 May 1997)

mc² DICOM Gateway Conformance Statement (mc²: GateStat.doc Rev 3, 13 Oct. 1999)

Definitions

The following definitions, acronyms, and abbreviations are used within this document:

AE	DICOM Application Entity.
Association	A (DICOM) association represents one entire communication session between two image devices. An association is initiated by a service class user device. The association may be terminated by either the SCU or SCP device.
BEAMVIEW	SIEMENS BEAMVIEW 2.1 portal imaging product.

DICOM	Digital Imaging and Communications in Medicine. A standard developed by the American College of Radiology (ACR) and the National Electrical Manufacturers Association (NEMA) for the electronic transfer of digital images.
Gateway	mc² Scientific Systems' DICOM Gateway™ product.
Image Bin	A directory location on a physical disk drive or file server where DICOM files are placed for temporary storage. The Gateway product writes DICOM files to an import image bin when a message is received from a DICOM SCU. The BEAMVIEW product writes DICOM files to an export image bin, which are in turn sent to a DICOM SCP by the Gateway product.
Image Study	A set of image objects intended to be displayed together, where each image represents a change in position through an axis of the body (e.g., a Computed Tomography study), or where each image represents a change in time (e.g., a portal image movie loop). Each image is saved by the Gateway as a separate file, all of which are later correlated and managed as a single image set by BEAMVIEW.
IOD	DICOM Information Object Definition.
RT	Radiation Therapy.
SCP	Service Class Provider. An imaging device is an SCP device if it provides DICOM services (responds to requests) over the TCP/IP network.
SCU	Service Class User. An imaging device is an SCU device if requests DICOM services over the TCP/IP network.
SOP	DICOM Service/Object Pair.
TCP/IP	Transmission Control Protocol/Internet Protocol. The suite of network protocols developed and used by DAR PA and US DOD.
UID	DICOM Unique Identifier.

2 Implementation Model

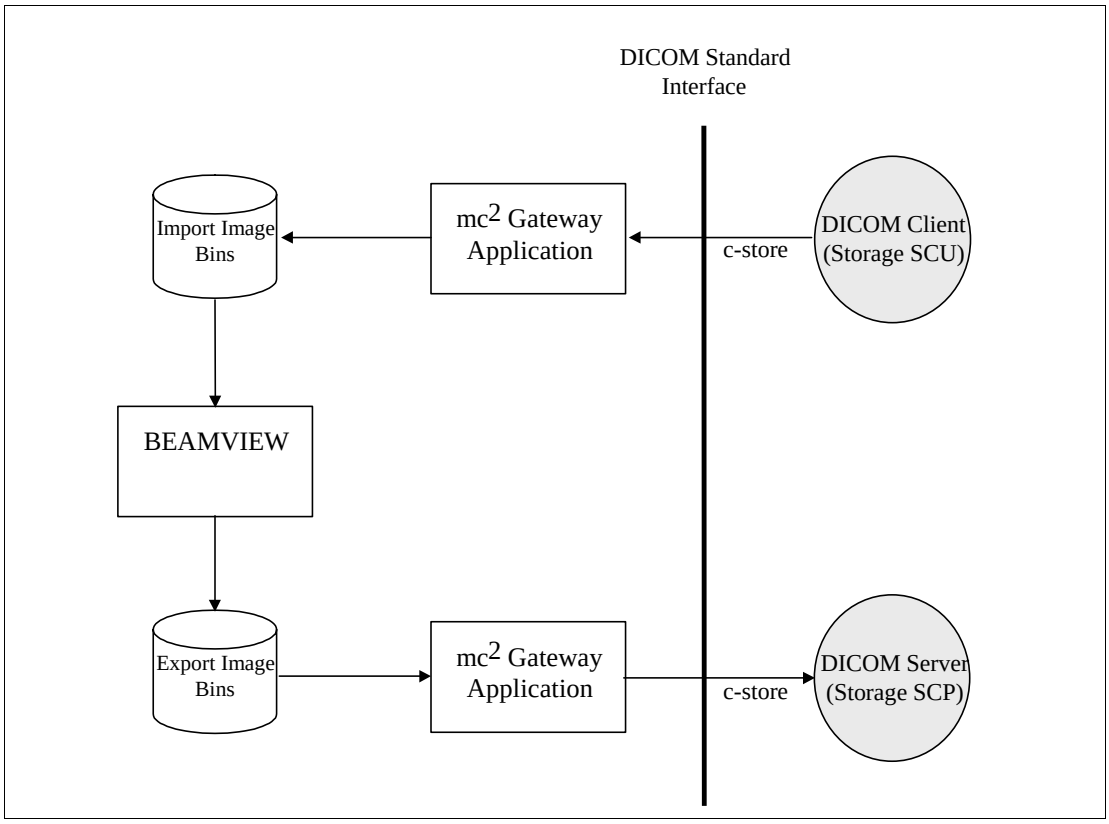
The Gateway and BEAMVIEW products are 32-bit applications designed to operate on Intel® x86 based platforms running the Microsoft Windows® NT® 4.0 operating systems. The Gateway product is configured to run on the same system that the BEAMVIEW application runs and is started automatically as part of the operating system initialization sequence. Once started, it runs continuously as a background task, usually in a minimized state. The BEAMVIEW product is designed to run on a workstation to acquire radiation therapy images. It also imports and exports DICOM files at the user's request.

The Gateway product is based on the Advanced Merge COM-3 implementation of DICOM provided by *Merge Technologies, Inc*.

Application Data Flow Diagram

The Gateway and BEAMVIEW products work together to provide a complete DICOM SCP and SCU. Once started, the Gateway waits for a DICOM client (SCU) to request an association. Association requests with Presentation Contexts for SOP Classes of the Storage Service Class are accepted. When the Gateway accepts an association, it receives image objects on these Presentation Contexts and writes them into uniquely named DICOM files in an image bin whose location is specified in a configuration file. The BEAMVIEW application then scans each image bin and correlates related DICOM files into image studies. A single image study may then be selected and imported into the BEAMVIEW product to serve as reference images. When the RT images are acquired using the BEAMVIEW product, they may then be exported to an image bin as a set of DICOM files. The Gateway scans each export image bin at specified intervals for files written by BEAMVIEW. If a file or file series is detected, the Gateway will attempt to open an association with the specified DICOM server (SCP) and will send the image objects using the presentation context specified in a configuration file.

This relationship between the Gateway and BEAMVIEW is shown in the following figure:



Functional Definitions of Application Entities

The Gateway application is a Service Class Provider (SCP) and a Service Class User (SCU) for the BEAMVIEW product. All communication and image transfer capabilities are implemented based on the DICOM protocol used over a TCP/IP network. When initiated, the Gateway alternately scans in two different modes: import and export.

In import mode, the Gateway waits for an association request over one of the valid TCP/IP ports listed in a configuration file. When a valid request is received (i.e. the client SCU is identified within the Gateway's application profile), the Gateway responds with a list of SOP class UIDs that it can process. It then waits for and processes storage requests. Each image object received is written into a uniquely named file in a specified import image bin.

In export mode, the Gateway scans specified export image bins for DICOM files created by the BEAMVIEW application. If a file or file series is detected, the Gateway will encode the DICOM files into DICOM image

objects, will initiate an association with the specified DICOM SCP, and will request a standard storage service. If the association is successful, the DICOM files in the export image bin are deleted; otherwise, they are moved to an aborted image bin.

Many DICOM configuration parameters such as the AE Title and scanning port number are maintained in configuration files. A log of all association attempts, successful or not, is maintained by the Gateway in a location specified in a configuration file.

The BEAMVIEW application is not an AE and does not communicate directly with the DICOM network. It imports and exports DICOM files from and to image bins whose locations are specified in a configuration file.

Sequencing of Real World Events

The BEAMVIEW application uses specialized file naming sequences (e.g. *.#) to associate independent DICOM files as image studies suitable for importing. Since the Gateway application does not attempt to interpret the content of DICOM image objects (i.e. they are simple pass-throughs), they cannot identify an image study based on standard DICOM elements.

In order to support image studies, the Gateway assumes that all individual image objects received on a single open association belong to a study and the files are named appropriately. Therefore, if a client SCU wishes to associate a collection of image objects as an image study, they must be sent over the same association. Image objects that are truly unrelated should be sent over separate associations.

3 Application Entity Specifications

Application Entity Specifications

The Gateway provides standard conformance to the following DICOM 3.0 Service Object Pair (SOP) Class as a Verification Service Class Provider (VSCP):

SOP Class Name	SOP Class UID
Verification SOP Class	1.2.840.10008.1.1

In addition, the Gateway application provides standard conformance to all DICOM 3.0 SOP classes as a Storage Class Provider (SCP) and a Storage Class User (SCU).

BEAMVIEW provides standard conformance to the following DICOM 3.0 SOP classes as a Storage Service Class User (SCU):

SOP Class Name	SOP Class UID
RT Image Information Object Storage	1.2.840.10008.5.1.4.1.1.481.1

Association Establishment Policies

General

The Gateway stores its AE title and TCP/IP listening port in a configuration file. These should be set according to vendor specific requirements. The Gateway also uses a DICOM application profile file, which contains a list of all client AEs, their host names (or TCP/IP addresses) and service lists. When a client SCU requests an association, the Gateway must find a valid entry for the SCU, otherwise, the association is rejected.

The maximum size of DICOM Protocol Data Units (PDUs) is configurable and may be set to 1024, 2048, 4096, 8192, 16,384 or any value >16,384 to a maximum of 32,768 bytes. The default configuration is 28,672 bytes.

Number of Associations

The Gateway is a multithreaded application that supports multiple associations from/to different client/server DICOM AEs at one time. A

maximum of six (6) concurrent associations may be active and processed in parallel by the Gateway.

Asynchronous Nature

The Gateway does not support asynchronous communications (i.e. multiple outstanding transactions over a single association).

Implementation Identifying Information

The Gateway uses the following identification values, which are stored in a configuration file:

Implementation Class ID	Implementation Version Name
2.16.840.1.113669.2.4.0	MergeCOM3_240

Association Initiation Policy

Once the Gateway has correlated a series of individual DICOM files as an Image Study, it will initiate an association with the specified remote DICOM server. The SOP class UID contained within the disk files is presented in the storage request. The Gateway will close the association once all files in the study have been sent. The Gateway or the remote server may abort the operation at any time if an error occurs.

Real World Activity: Send Image Object

Associated Real World Activity: Read and Send Image Object

Once an association is established, the Gateway will read each disk-based DICOM file and will attempt to send it to the remote server using a standard DICOM C-STORE request. The remote server must either accept or reject the request.

Presentation Context Table

The Gateway application will use the presentation context contained within disk based DICOM files that it reads. BEAMVIEW will write such files using the following storage SOP presentation contexts:

Table 1. Presentation Context Table

Abstract Syntax		Transfer Syntax		Role	Extended
Name	**UID**	**Name List**	**UID List**		**Negotiation**
RT Image Storage	1.2.840.10008.5.1.4.1.1.481.1	DICOM Implicit VR Little Endian	1.2.840.10008.1.2	SCU	None

SOP Specific Conformance

The Gateway provides standard conformance to the presentation contexts listed above. A table of type 3 elements included with each SOP is listed in the appendices.

Association Acceptance Policy

The Gateway will poll the TCP/IP port at specified intervals for client (SCU) association requests. The AE title of the client SCU must be found in a local configuration file or the association will be rejected. The association will also be rejected if there are insufficient resources for storage.

Receive Echo

Associated Real World Activity: Respond to Echo

The Gateway responds to echo requests with a standard DICOM C-ECHO response.

Presentation Context Table

The Gateway application will accept the following verification SOP Presentation Contexts:

Table 2. Presentation Context Table

Abstract Syntax		Transfer Syntax		Role	Extended
Name	**UID**	**Name List**	**UID List**		**Negotiation**
Verification Service Class	1.2.840.10008.1.1	DICOM Implicit VR Little Endian	1.2.840.10008.1.2	SCP	None
		DICOM Explicit VR Big Endian	1.2.840.10008.1.2.2		
		DICOM Explicit VR Little Endian	1.2.840.10008.1.2.1		

SOP Specific Conformance

The Gateway provides standard conformance for the DICOM Verification Service Class listed above.

Real World Activity: Receive Image Object

Associated Real World Activity: Receive and Store Image Object

Once an association has been established, the Gateway will respond to standard DICOM C-STORE requests for those presentation contexts listed below. The Gateway will create a new unique image study number for the series of DICOM files to be written to. A standard C-STORE response is sent for each message received by the Gateway to indicate the success or failure of the storage request.

Presentation Context Table

The Gateway application will accept the following storage SOP Presentation Contexts:

Table 3. Presentation Context Table

Abstract Syntax		Transfer Syntax		Role	Extended
Name	**UID**	**Name List**	**UID List**		**Negotiation**
RT Image Storage	1.2.840.10008.5.1.4.1.1.481.1	DICOM Implicit VR Little Endian	1.2.840.10008.1.2	SCP	None
		DICOM Explicit VR Little Endian	1.2.840.10008.1.2.1		
		DICOM Explicit VR Big Endian	1.2.840.10008.1.2.2		

SOP Specific Conformance

The Gateway provides Standard Conformance for the DICOM Storage Classes listed above. A list of type 2 and type 3 elements required by BEAMVIEW in order to import image studies is included in the appendices.

Presentation Context Acceptance Criterion

The Gateway supports any of the verification and storage SOP classes listed in the tables above. Any other Presentation Contexts will be rejected and the association will be closed.

Transfer Syntax Selection Policies

The Gateway supports any of the transfer syntaxes listed in the presentation context tables above. Any Presentation Context not incorporating one of these transfer syntaxes will be rejected and the association will be closed.

4 Communication Profiles

Supported Communication Stacks

OSI Stack

The OSI Stack is not supported.

TCP/IP Stack

API

The Gateway uses the Windows Sockets API inherent to the Microsoft Windows95 and Microsoft WindowsNT operating systems.

Physical Media Support

All physical media that is supported by the TCP/IP stack may be used with the Gateway. This includes, but is not limited to, 10-Base-2, 10-Base-T, fiber optic and Internet.

Point To Point Stack

The Point-to-Point Stack is not supported.

5 Extensions/Specializations/ Privatizations

Standard Extended/Specialized/Private SOPs

As pass-throughs, the Gateway application will receive and store extended, specialized and private SOPs. BEAMVIEW, however, does not support specialized or private SOPs.

Private Transfer Syntaxes

None supported.

6 Configuration

AE Title/Presentation Address Mapping

The Gateway AE title and presentation address mappings are fully configurable. Vendor specific configuration instructions should be used for each installation to avoid potential conflicts with other imaging sources.

Configurable Parameters

The following table shows the Gateway's configurable parameters along with their default values:

Parameter	Default Value
Gateway AE Title	SIEMENS_BV
Listening port	104
Message Time-out	30 sec.
Implementation Class UID	2.16.840.1.113669.2.4.0
Implementation Version Name	MergeCOM3_240
PDU Maximum Length	28672

7 Support of Extended Character Sets

None supported.

A Type 2/3 Elements Required for Import

In addition to the required type 1 elements defined by the DICOM standard, the BEAMVIEW application requires RT Image objects to contain valid data for the following DICOM type 2/3 elements in order to be associated with an image study and imported into the application:

Table 4. RT IMAGE IOD

GROUP	ELEMENT	NAME	DESCRIPTION
0010	0010	Patient Name	Patient's full name.
0010	0020	Patient ID	Primary hospital identification number or code for the patient.

B Elements Supported During Import

In addition to the required elements defined in Appendix A, the BEAMVIEW will import, validate and maintain the following DICOM elements from the RT Image IOD:

Table 5. RT IMAGE IOD

GROUP	ELEMENT	NAME	DESCRIPTION
0008	0020	Study Date	Date the study started.
0008	0030	Study Time	Time the study started.
0008	0023	Image Date	The date the image pixel data creation started.
0008	0033	Image Time	The time the image pixel data creation started.
0010	0030	Patient Birth Date	Birth date of the patient.
0010	0040	Patient Sex	Sex of named patient. If value is M or F, it cannot be changed within BEAMVIEW.
0008	0070	Manufacturer	Manufacturer of the equipment that produced the digital images.
0008	0080	Institution Name	Institution where the image equipment is located that produced the digital images.
0008	0090	Referring Physician's Name	Patients referring physician.
0008	1090	Manufacturer's Model Name	Manufacturer's model number of the equipment that produced the images.
0018	1020	Software Version(s)	Manufacturer's designation of the software version used on the equipment that produced the images.

Table 5. RT IMAGE IOD (continued)

300A	00B6	>Beam Limiting Device Sequence	Introduces sequence of beam limiting device (collimator) jaw or leaf (element) positions for a given exposure.
300A	011E	Gantry Angle	Treatment machine gantry angle, i.e. orientation of IEC GANTRY coordinate system with respect to IEC FIXED REFERENCE coordinate system (degrees).
300A	0120	Beam Limiting Device Angle	Treatment machine beam limiting device (collimator) angle, i.e. orientation of IEC BEAM LIMITING DEVICE coordinate system with respect to IEC GANTRY coordinate system (degrees).

C Type 2/3 Elements Exported

The BEAMVIEW application maintains and exports all DICOM type 2 attributes for which values are known, as is required by the DICOM Specification. The following type 2 attributes are exported with the additional usage notes indicated.

Table 6. RT IMAGE IOD

GROUP	ELEMENT	NAME	DESCRIPTION
3002	0011	Image Plane Pixel Spacing	Physical distance (in mm) between the center of each image pixel, specified by a numeric pair – adjacent row spacing (delimiter) adjacent column spacing.[1]
3002	0022	Radiation Machine SAD	Radiation source to Gantry rotation axis distance of radiation machine used in acquiring or computing image (in mm).
3002	0026	RT Image SID	Distance from radiation machine source to image plane (in mm) along radiation beam axis.

Note 1. The Image Plane Pixel Spacing is given in distance units on the plane at the Radiation Machine SAD, which is the expected encoding for a Digitally Reconstructed Radiograph (DRR) without a defined RT Image SID. However, this is inconsistent with the usage note in DICOM Specification Part 3, section C.8.8.2.3, which states that the Image Plane Pixel Spacing should be given at the RT Image SID, if the image has a known SID. In this case the pixel spacing will differ from the expected value by a factor of SAD / SID.

The BEAMVIEW application maintains and exports the following DICOM type 3 elements:

Table 7. RT IMAGE IOD

GROUP	ELEMENT	NAME	DESCRIPTION
0008	0070	Manufacturer	Manufacturer of the equipment that produced the digital images.
0008	0080	Institution Name	Institution where the image equipment is located that produced the digital images.
0008	1090	Manufacturer's Model Name	Manufacturer's model number of the equipment that produced the images.
0018	1020	Software Version(s)	Manufacturer's designation of the software version used on the equipment that produced the images.
0008	0090	Referring Physician's Name	Patient's referring physician.
300A	00B6	>Beam Limiting Device Sequence	Introduces sequence of beam limiting device (collimator) jaw or leaf (element) positions for a given exposure.
300A	011E	Gantry Angle	Treatment machine gantry angle, i.e. orientation of IEC GANTRY coordinate system with respect to IEC FIXED REFERENCE coordinate system (degrees).
300A	0120	Beam Limiting Device Angle	Treatment machine beam limiting device (collimator) angle, i.e. orientation of IEC BEAM LIMITING DEVICE coordinate system with respect to IEC GANTRY coordinate system (degrees).